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Abstract

Adding .6 pound fat or .22 pound sodium bicarbonate (soda) to finishing rations containing rolled wheat significantly improved performance and appeared to increase the substitution value of wheat. Both fat and soda increased feed intake. The improved gains from adding fat corresponded to increased energy intake. However, soda seemed to enhance nutrient utilization. There was more response to fat when we fed 100 percent vs. 50 percent wheat, but feeding 100 percent wheat depressed performance, with or without fat, to unsatisfactory levels.

Keywords

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Adding Fat and/or Sodium Bicarbonate to Steer Finishing Rations That Contain Wheat

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Summary

Adding .6 pound fat or .22 pound sodium bicarbonate (soda) to finishing rations containing rolled wheat significantly improved performance and appeared to increase the substitution value of wheat. Both fat and soda increased feed intake. The improved gains from adding fat corresponded to increased energy intake. However, soda seemed to enhance nutrient utilization. There was more response to fat when we fed 100 percent vs. 50 percent wheat, but feeding 100 percent wheat depressed performance, with or without fat, to unsatisfactory levels.

Introduction

In Kansas, wheat is often priced competitively with other ingredients for feeding cattle. However, feeding wheat may involve extra management and special ration formulation. Past research has indicated that adding fat and sodium bicarbonate (soda) may be especially beneficial when wheat is fed. We conducted four trials at Hays to evaluate those ingredients. This project is a joint effort by scientists from the Department of Animal Sciences and Industry and the Hays and Garden City Branch Experiment Stations.

Experimental Procedures

Four feeding trials were conducted with heavy yearling steers that were mostly Angus x Hereford. Cattle were fed in groups of 16 to 27 head. The tables include details of rations and performance for each trial. The first two trials evaluated adding fat to milo, milo and wheat, and all-wheat finishing rations. We dropped the all-wheat rations and tested soda additions in trials 3 and 4.

Both milo and wheat were finely rolled. Forage sorghum silage and prairie hay were used as roughage. When fat was fed, we added .3 lb per head per day the first few days, then fat was increased to .6 lb per day. The fat was a mixture of soybean oil and beef tallow that melted at about 100° F. The soda level was .22 lb (100 g) per day. Milo rations were supplemented with soybean meal and urea but no supplemental protein was needed (except for the first few days) when wheat was fed. Rumensin® and Tylan® were fed with a premix that contained Vitamin A, niacin, zinc methionine, and trace minerals. Rations also contained ammonium sulfate and ground limestone.

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Implanting experiments were superimposed on the feeding trials, so most cattle were implanted. The remarkable gains in Trial 4 partially resulted from research with an experimental implant combination. All cattle were followed through a packing plant and carcass data were obtained. Initial weights were adjusted to actual "pay weight" and final weights were adjusted to a constant 62 dressing percentage.

In order to calculate individual energy gains, we estimated body composition at the end of each trial using equation 1:

$$C = 4.0525 - .002048\ X + .1292\ Y + 1.8214\ Z \quad (1)$$

C = Caloric density of soft tissue (C/gram)
X = Carcass weight (pounds)
Y = Marbling score (small amount = 5; modest = 6)
Z = Backfat thickness (inches)

Equation 2 expresses individual energy gains as a function of both relative rate of gain and body fatness.

$$E = X\ (.1244 + .8756\ G/g)\ (.11 + .8\ C/c) \quad (2)$$

E = Energy gain for each individual (Mcal/day).
X = Standard energy gain for the group (energy gain calculated from intake of a standard ration or average energy gain for the set calculated from national Research Council equations that estimate net energy gain from metabolic weight and live weight gain).
G/g = Ratio of average daily gain for each indivdual to group average daily gain.
C/c = Ratio of individual caloric density to the group or a standard set average.
(The constants adjust live weight gain for gain that is gut fill and for tissues that do not change composition).

We calculated net energy gain with this procedure to compare with net energy gain estimated from feed intake. That enabled us to determine if differences in feed intake accounted for differences in performance. The ratios are included in the tables. We interpreted a ratio above 1 as an indication that the ration was utilized better than expected.

Cost of gain used to determine relative value of wheat included both feed and fixed costs. We assigned $0.50 per day to cover interest, yardage, and miscellaneous. The difference in total cost per 100 pounds gain between the wheat-containing ration and the standard milo ration was divided by the pounds of wheat per 100 pounds gain to calculate the effective substitution price for wheat. We did not try to economically evaluate possible differences in carcass quality. Our procedure penalized reductions in animal performance (sometimes seen with wheat rations) severely, but more accurately reflected feedlot closeouts than comparisons that used only feed efficiency or feed costs.

Results and Discussion

Tables 2.1 to 2.4 contain the detailed results of each trial. However, Tables 2.5 to 2.7 condense the most important indications. Adding fat (Table 2.5) significantly increased feed intake and gain. Since a pound of fat contained more net energy than 2.5 pounds of milo, the small increases in total feed intake accounted for all the weight gain increase. There was a significant trend for fat addition to improve feed efficiency more as the proportion of wheat increased. Also, fat improved carcass grade when we fed 100 percent wheat (Table 2.1). Feed intake was consistently reduced when rations contained wheat; fat may have restored net energy intake to the level needed for maximum performance.

Soda also significantly increased feed intake and gain (Table 2.6). The response to soda was the same whether or not fat was included. However, soda differed from fat by apparently improving energy utilization. It might create a more favorable rumen environment or it might increase rumen turnover rates and cause more nutrients to be absorbed in the lower digestive tract.

In Table 2.7 we have attempted to estimate the relative substitution values of wheat. These values may differ from those published elsewhere, because our values are based on actual performance data. When the standard ration was fed in these four trials, wheat had to be priced 5 percent less per pound than milo to result in cheaper gain. A possible reason why the equivalent value of wheat was so low may have been our penalty for reduced rate of gain (gains averaged 10 percent less when wheat was fed). Also, our other research suggests that improved processing and feeding Rumensin® or Bovatec® may benefit milo more than wheat. Protein prices were low during those tests, so the ability to substitute wheat for soybean meal was relatively unimportant. Price relationships vary with cattle requirements and costs of other ingredients. They should be recalculated for each situation.

Average daily gain (adjusted to a constant dressing percent) was about 200 percent less when wheat was the only grain fed. While cattle can be fed a ration containing wheat as the only grain, it appears that wheat would have to be very cheap in relation to other grains for that to be feasible. It is possible that steam flaking results in substantially better relative performance when high-wheat levels are fed.

Both fat and soda increased the relative value of wheat (Table 2.7) by significantly improving animal performance. In one test, feeding both soda and fat enabled a 40 percent premium for wheat over milo; however, that large a response needs confirmation. Also, the design of our tests did not completely evaluate responses to fat and soda in rations that contained only milo.

Table 2.1. Adding Fat to Milo, Milo-wheat, and Wheat Rations. October 1, 1984, to January 12, 1985, 105 days. Trial 1

Item	Milo	Milo-fat	Milo-wheat	Milo-wheat fat	Wheat	Wheat fat
Number of head	25	25	25	24	25	25
Initial weight	777.6	782.4	780.6	776.9	782.9	779.1
Final weight[1]	1204.7	1220.7	1169.7	1201.6	1115.7	1150.7
Average gain	427.1	438.3	389.1	424.7	332.8	371.6
Average daily gain, lb	4.07	4.17	3.71	4.04	3.17	3.54
Average daily ration, lb:						
Sorghum silage	11.50	11.47	11.26	11.35	10.97	11.20
Prairie hay	.45	.52	.37	.35	.30	.30
Rolled milo	24.57	24.18	10.91	11.02	—	—
Rolled wheat	—	—	10.91	11.02	18.94	19.11
Soybean meal	.60	.60	.05	.05	.03	.03
Urea	.05	.05	.01	.01	—	—
Fat	—	.58	—	.58	—	.55
Premix[2]	.55	.55	.55	.55	.55	.55
Dry matter total	25.14	25.45	22.67	23.45	20.45	21.24
Carcass data:						
Dressing percent	62.05	61.81	60.88	61.62	60.49	61.09
Backfat, in	.46	.52	.41	.44	.37	.41
Marbling score	4.82	5.21	5.05	4.99	4.54	4.88
Percent choice	80.%	84.%	88.%	83.%	52.%	80.%
Lb D M/100 lb gain[3]	618.0	609.6	611.7	579.6	645.0	600.1
Feed cost/cwt gain[3]	$28.34	$29.08	$29.08	$29.17	$32.12	$31.66
Total cost/cwt gain	$40.63	$41.49	$42.57	$41.53	$47.89	$45.79
Value of wheat (cwt) equal to milo @ $3.80	—	—	$3.84	$4.17	$3.28	$3.54
Caloric density, C/g	3.98	4.11	3.98	3.98	3.92	3.97
Energy gain, Mcal/day	9.76	10.31	9.04	9.72	7.81	8.74
Ratio of observed to predicted gain	1.00 (milo)	.99 (milo)	1.02 (wheat)	.99 (wheat)	.98 (wheat)	.98 (wheat)
Net energy values						
NE gain (Mcal/kg DM)	1.40	1.39	1.53	1.50	1.48	1.49
NE maintenance	2.12	2.10	2.40	2.33	2.29	2.31

[1]Final weights and gains adjusted to dressing percent of 62. Initial weights [2]adjusted to pay weights.
[2]Premix included .11 lb ammonium sulfate, .22 lb ground limestone, niacin, zinc [3]methionine, Rumensin, Tylan, vitamin A, and trace minerals.
[3]Costs based on milo, $3.80/cwt; wheat, $4.50/cwt; silage, $16/ton; soybean meal, $140/ton; 50 cents per day for interest, yardage, and miscellaneous costs (fat and sodium bicarbonate priced at 17 cents per pound).

Table 2.2. Adding Fat to Milo, Milo-wheat, and Wheat Rations. January 18, 1985, to May 4, 1985, 107 days. Trial 2

Item	Milo	Milo-fat	Milo-wheat	Milo-wheat fat	Wheat	Wheat fat
Number of head	27	26	27	27	27	26
Initial weight	858.3	868.3	862.8	859.9	862.5	864.7
Final weight[1]	1198.2	1246.5	1182.7	1211.4	1132.4	1189.4
Average gain	339.9	378.2	319.9	351.5	269.9	324.7
Average daily gain, lb	3.18	3.53	2.99	3.28	2.52	3.04
Average daily ration, lb:						
Sorghum silage	11.00	10.96	10.52	10.94	10.54	10.70
Prairie hay	.48	.51	.46	.34	.36	.39
Rolled milo	21.15	21.87	9.97	9.40	—	—
Rolled wheat	—	—	9.97	9.40	17.42	17.32
Soybean meal	.60	.60	.05	.05	.05	.05
Urea	.05	.05	.01	.01	.01	.01
Fat	—	.58	—	.58	—	.58
Premix[2]	.55	.55	.55	.55	.55	.55
Dry matter total	22.36	23.58	21.06	20.70	19.15	19.73
Carcass data:						
Dressing percent	61.92	62.68	61.52	62.66	60.76	61.86
Backfat, in	.40	.48	.42	.46	.36	.43
Marbling score	5.10	5.09	4.93	4.83	4.65	4.72
Percent choice	89.%	88.%	74.%	74.%	63.%	65.%
Lb D M/100 lb gain[3]	703.9	667.0	704.4	630.2	759.5	650.0
Feed cost/cwt gain	$32.10	$32.35	$33.32	$31.82	$37.68	$34.37
Total cost/cwt gain	$47.84	$46.40	$50.04	$46.94	$57.51	$50.74
Value of wheat (cwt) equal to milo @ $3.80	—	—	$3.84	$4.81	$3.10	$3.99
Caloric density, C/g	3.93	4.03	3.94	3.97	3.88	3.94
Energy gain, Mcal/day	8.01	9.00	7.73	8.34	6.51	7.75
Ratio of observed to predicted gain	1.00 (milo)	.98 (milo)	.99 (wheat)	1.04 (wheat)	.93 (wheat)	1.00 (wheat)
Net energy values						
NE gain (Mcal/kg DM)	1.40	1.38	1.49	1.57	1.43	1.50
NE maintenance	2.12	2.08	2.30	2.48	2.18	2.32

[1]...Footnotes in Table 1.

Table 2.3. Fat and Sodium Bicarbonate in Steer Finishing Rations Containing Wheat. May 21, 1985, to October 8, 1985, 141 days. Trial 3

Item	Milo	Milo-fat	Milo-wheat	Milo-wheat fat	Milo-wheat soda	Milo-wheat soda fat
Number of head	18	18	17	17	17	17
Initial weight[1]	728.3	726.9	722.9	728.6	731.3	728.8
Final weight[1]	1162.4	1158.2	1119.5	1192.8	1174.3	1246.4
Average gain	434.1	531.3	396.6	464.2	443.0	517.4
Average daily gain, lb	3.08	3.77	2.81	3.29	3.14	3.67
Average daily ration, lb:						
Sorghum silage	10.02	10.39	10.10	10.29	10.27	10.45
Prairie hay	.14	.22	.11	.12	.12	.09
Rolled milo	20.02	22.28	9.10	9.86	9.82	10.44
Rolled wheat	—	—	9.10	9.86	9.82	10.44
Soybean meal	.60	.60	.03	.03	.03	.03
Urea	.05	.05	—	—	—	—
Fat	—	.59	—	.59	—	.59
Sodium bicarbonate[2]	—	—	—	—	.22	.22
Premix	.55	.55	.55	.55	.55	.55
Dry matter total	21.26	23.95	19.49	21.45	20.79	22.50
Carcass data:						
Dressing percent	62.57	64.46	61.86	62.82	62.35	63.64
Backfat, in	.41	.55	.33	.45	.40	.49
Marbling score	4.23	4.71	3.85	4.32	4.11	4.28
Percent choice	28.%	72.%	24.%	29.%	35.%	41.%
Lb D M/100 lb gain[3]	690.5	635.7	692.9	651.5	661.7	613.1
Feed cost/cwt gain	$31.19	$30.39	$32.34	$32.73	$32.06	$31.45
Total cost/cwt gain	$47.42	$43.66	$50.12	$47.62	$48.00	$45.09
Value of wheat (cwt) equal to milo @ $3.80	—	—	$3.68	$4.43	$4.32	$5.32
Caloric density, C/g	3.85	4.03	3.71	3.91	3.83	3.91
Energy gain, Mcal/day	7.83	9.82	6.99	8.48	7.89	9.31
Energy gain predicted from feed intake	7.83	9.88	7.30	8.97	8.04	9.58
Ratio of observed to predicted gain	1.00	.99	.96	.95	.98	.97

[1]...Footnotes in Table 1.

Table 2.4. Fat and Sodium Bicarbonate in Steer Finishing Rations Containing Wheat. September 18, 1985, to December 17, 1985, 91 days. Trial 4

Item	Milo	Milo-fat	Milo-wheat	Milo-wheat fat	Milo-wheat soda	Milo-wheat soda fat
Number of head	18	18	17	16	17	18
Initial weight[1]	851.5	850.6	854.2	849.3	849.6	846.2
Final weight[1]	1265.5	1267.5	1203.8	1230.6	1248.6	1269.4
Average gain	414.0	416.9	349.6	381.3	399.0	423.2
Average daily gain, lb	4.55	4.58	3.84	4.19	4.38	4.65
Average daily ration, lb:						
Sorghum silage	14.38	14.26	12.42	12.21	12.70	12.83
Prairie hay	.21	.21	.14	.05	.14	.09
Rolled milo	24.94	24.70	11.16	10.98	11.56	11.63
Rolled wheat	—	—	11.16	10.98	11.56	11.63
Soybean meal	.60	.60	.06	.06	.06	.06
Urea	.06	.06	.01	.01	.01	.01
Fat	—	.57	—	.57	—	.57
Sodium bicarbonate[2]	—	—	—	—	.22	.22
Premix	.55	.55	.55	.55	.55	.55
Dry matter total	26.26	26.62	23.43	23.55	24.42	25.10
Carcass data:						
Dressing percent	63.40	63.51	61.87	62.50	62.84	63.29
Backfat, in	.41	.48	.40	.45	.39	.50
Marbling score	4.70	4.82	4.84	4.59	4.62	4.71
Percent choice	72.2%	66.7%	88.2%	68.8%	58.8%	66.7%
Lb D M/100 lb gain[3]	577.1	581.0	609.8	562.1	556.9	539.5
Feed cost/cwt gain	$26.00	$27.62	$28.69	$28.04	$26.80	$27.34
Total cost/cwt gain	$36.99	$38.60	$41.14	$39.48	$37.88	$37.90
Value of wheat (cwt) equal to milo @ $3.80	—	—	$3.07	$3.55	$4.16	$4.14
Caloric density, C/g	3.79	3.94	3.86	3.91	3.77	3.97
Energy gain, Mcal/day	10.28	10.65	8.97	9.70	9.83	10.88
Energy gain predicted from feed intake	10.22	10.97	9.24	9.84	9.67	10.61
Ratio of observed to predicted gain	1.01	.97	.97	.99	1.02	1.03

[1]...Footnotes in Table 1.

Table 2.5. Adding .6 lb Fat to Milo, Milo-wheat, or Wheat Rations for Finishing Steers. Summary of Four Trials

Item	Milo	Milo-fat	Milo-wheat	Milo-wheat-fat	Wheat	Wheat-fat
Average daily gain, lb	3.72	4.01	3.34	3.70	2.92	3.36
Average DM intake, lb	23.75	24.90	21.66	22.28	19.89	20.58
Lb DM/100 lb gain	643.1	621.7	651.7	603.7	687.8	616.2
Ratio of observed net energy gain to predicted net energy gain	100.00	97.97	98.37	98.90	94.03	97.68

Table 2.6. Adding 100 Grams Sodium Bicarbonate to Milo-wheat Rations for Finishing Steers. Summary of Two Trials

Item	Control	Fat	Soda	Soda + Fat
Average daily gain, lb	3.32	3.74	3.76	4.16
Average DM intake, lb	21.46	22.50	22.60	23.80
Lb DM/100 lb gain	648.7	603.5	604.8	574.0
Ratio of observed net energy gain to predicted net energy gain	96.11	96.30	99.63	99.57

Table 2.7. Effect of Adding Fat or Sodium Bicarbonate on the Relative Value of Wheat. Summary of Four Trials

Trial	Substitution Value of Wheat as Percent of Milo Price					
	Milo-wheat	Milo-wheat-fat	Wheat	Wheat-fat	Milo-wheat-soda	Milo-wheat-soda-fat
Trial 1	101	110	86	93	—	—
Trial 2	101	127	76	98	—	—
Trial 3	97	117	—	—	114	140
Trial 4	81	93	—	—	109	109
Average	94.9	111.6	81.2	95.8	111.6	124.5